

S P E C I F I C A T I O N

Docket No. **SILA0007**

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT I, **Scott Allan Woodford**, a citizen of the United States of America, residing in the State of Texas, have invented new and useful improvements in a

LOW-NOISE BLOCK CONTROLLER WITHIN A SET-TOP BOX

of which the following is a specification:

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates to set-top boxes in general, and in particular to a low-noise block (LNB) controller within a set-top box. Still more particularly, the present invention relates to an LNB controller within a set-top box for controlling an LNB amplifier on a directional receiver antenna.

2. Description of Related Art

A digital satellite communication system typically employs a ground-based transmitter to beam an uplink signal to a satellite that is positioned in a geosynchronous orbit. In turn, the satellite relays the signal back to various ground-based receivers. Such a digital satellite communication system permits a household (or business) subscribing to a satellite television service to receive audio and video signals directly from the satellite by means of a directional receiver antenna that is typically affixed to the roof or an external wall of the subscriber's residence.

A directional receiver antenna constructed to receive satellite signals typically includes a dish-shaped reflector that has a feed support arm protruding outward from the front surface of the reflector. The feed support arm supports an assembly in the form of a low-noise block (LNB) amplifier having an integrated LNB feed. The reflector collects and focuses satellite signals onto the LNB feed.

The satellite signals are commonly received at the Ku-band or C-band. The received satellite signals are first amplified by the LNB amplifier and then downshifted to a predetermined frequency band, typically in the L-band. The satellite signals are

1 subsequently sent via a coaxial cable to a set-top box typically located adjacent to a
2 subscriber's television.

3
4 The components within a set-top box can be divided into two major sections,
5 namely, an LNB control section and a signal processing section. The signal processing
6 section is beyond the scope of the present disclosure. The present disclosure provides an
7 improved control device for the LNB control section of a set-top box.

SUMMARY OF THE INVENTION

In accordance with a preferred embodiment of the present invention, a low-noise block (LNB) control device capable of controlling modulation of an alternating waveform on a direct current (DC) voltage from a DC power supply to an LNB amplifier includes a power supply control module, an LNB signaling module and a switch. In response to a power supply feedback signal received from the DC power supply, the power supply control module sends a control signal to the DC power supply. In addition, the LNB signalling module provides a switch control signal and a modulating waveform to the switch. Under the control of switch control signal, the switch selectively sends the modulating waveform to a summing circuit that is located external to the LNB control device. Within the summing circuit, the modulating waveform is added to the DC voltage from the DC power supply.

All objects, features, and advantages of the present invention will become apparent in the following detailed written description.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention itself, as well as a preferred mode of use, further objects, and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

Figure 1 is a conceptual diagram of a low-noise block control section within a set-top box, in accordance with a preferred embodiment of the present invention;

Figure 2 is a block diagram of a low-noise block control section within a set-top box, in accordance with a preferred embodiment of the present invention; and

Figure 3 is a circuit diagram of the low-noise block control section from Figure 2, in accordance with a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawings and, in particular, to Figure 1, there is depicted a conceptual diagram of a low-noise block (LNB) control section within a set-top box, in accordance with a preferred embodiment of the present invention. As shown, an LNB control section 10 includes a DC power supply 11, a summing circuit 12, a filter 13 and a switch 14. LNB control section 10 controls the functionality of an LNB amplifier 15 located remotely from LNB control section 10.

As part of LNB control section 10, an LNB control device 16 generates various control signals. For example, LNB control device 16 provides a modulating signal to be added to a DC voltage, which is generated by DC power supply 11, via an input 17 at summing circuit 12. In addition, LNB control device 16 provides a switch control signal to control switch 14 via an input 18 at switch 14.

LNB control section 10 operates under two separate modes, namely, a transmitting mode and a receiving mode. During the transmitting mode, switch 14 is closed, allowing the DC voltage along with the modulating signal to send to LNB amplifier 15 bypassing filter 13. Also, filter 13 appears to LNB amplifier 15 as a low or zero impedance device during the transmitting mode. During the receiving mode, switch 14 is open to provide the desired impedance of filter 13 between DC power supply 11 and LNB amplifier 15.

With reference now to Figure 2, there is depicted a block diagram of an LNB control section within a set-top box, in accordance with a preferred embodiment of the present invention. As shown, an LNB control section 20 includes a DC power supply 21, a filter 22, a summing circuit 23, and an LNB control device 26. Filter 22 has a relatively low DC impedance and a defined AC impedance. As such, filter 22 does not significantly impair DC power supply 21 from providing power to an LNB amplifier 25

1 while providing a specific AC impedance to LNB amplifier 25 at the same time. Summing
2 circuit 23 allows a modulating signal to be added to a DC voltage that is generated by DC
3 power supply 21, via an input 36 at summing circuit 23.

4
5 LNB control device 26 includes a switch 24, an LNB signaling module 27,
6 a power supply control module 28 and a high impedance resistor 29. Switch 24 can be
7 switched to a position A or a position B according to a switch control signal 31 provided
8 by LNB signaling module 27. In the present embodiment, position A of switch 24 is
9 associated with a modulating signal 32 provided by LNB signaling module 27, and position
10 B of switch 24 is associated with a high impedance provided by high impedance resistor
11 29. Thus, modulating signal 32 is sent to summing circuit 23 when switch 24 is at position
12 A, and a high impedance is connected to summing circuit 23 when switch 24 is at position
13 B.

14
15 In addition, LNB control device 26 controls DC power supply 21 via a
16 power supply control signal generated by power supply control module 28 sent to DC
17 power supply 21 on a power supply control line 34. In turn, DC power supply 21 provides
18 a feedback signal to power supply control module 28 of LNB control device 26 via a
19 feedback line 35. Power supply control module 28 sends the power supply control signal
20 to DC power supply 21 according to the feedback signal received from DC power supply
21 21. LNB control device 26 also receives a feedback signal from LNB amplifier 25 via a
22 feedback line 33.

23
24 LNB control section 20 is preferably situated within a set-top box that is
25 typically located adjacent to a satellite television subscriber's television. LNB amplifier 25
26 is preferably located on a feed support arm of a directional receiver antenna that is typically
27 located remotely from LNB control section 20. LNB control section 20 controls the
28 functionality of LNB amplifier 25 on the direction receiver antenna.

As mentioned above, LNB control section **20** operates under two separate and distinct modes, namely, a transmitting mode and a receiving mode. During the transmitting mode, switch **24** is located at position A such that the DC voltage from DC power supply **21** along with modulating signal **32** are allowed to pass to LNB amplifier **25**. LNB amplifier **25** "sees" filter **22** and summing circuit **23** as negligibly low impedance devices during the transmitting mode. During the receiving mode, switch **24** is located at position B. With switch **24** being at position B, the AC impedance presented to LNB amplifier **25** is dominated by the AC impedance of filter **22** if the impedance of high impedance resistor **29** is chosen to be relatively high. LNB amplifier **25** "sees" filter **22** as a high impedance device during the receiving mode. Thus, it is imperative that the impedance value of high impedance resistor **29** is chosen to be high enough so that the impedance presented to LNB amplifier **25** can be dominated by the impedance of filter **22**.

Referring now to Figure 3, there is illustrated a circuit diagram of LNB control section **20**, in accordance with a preferred embodiment of the present invention. As shown, DC power supply **21**, filter **22** and summing circuit **23** of LNB control section **20** are discrete components located outside LNB control device **26**. Filter **22** includes an inductor L_f , a resistor R_f and a capacitor C_f connected parallel to each other. Preferably, the values of inductor L_f , resistor R_f and capacitor C_f are $100\ \mu\text{H}$, $15\ \Omega$ and $0.47\ \mu\text{F}$, respectively. Summing circuit **23** includes a resistor R_s , a capacitor C_s and a transistor Q_s . Resistor R_s is connected in series with capacitor C_s . The collector of transistor Q_s is connected to resistor R_s , and the base of transistor Q_s is connected to the node between resistor R_s and capacitor C_s . The emitter of transistor Q_s is connected to LNB amplifier **25**. Preferably, the values of resistor R_s and capacitor C_s are $2.2\ \text{k}\Omega$ and $0.1\ \mu\text{F}$, respectively. Transistor Q_s is preferably a darlington NPN transistor.

Switch **24**, which is located within LNB control device **26**, includes transistors T1-T4 and an inverter I. Transistors T1-T4 are preferably field effect transistors (FETs), with transistors T1 and T3 being n-channel FETs and transistors T2 and T4 being

1 p-channel FETs. Switch **24** is also connected to high impedance resistor **29**, a modulating
2 voltage source V1 and an offset voltage source V2. The resistance of high impedance
3 resistor **29** is preferably 100 k Ω . Preferably, the voltage of modulating voltage source V1
4 is approximately ± 0.4 V, and the voltage of offset voltage source V2 is approximately 2.6
5 V.

6
7 Transistors T1 and T2 are connected to each other in a transmission gate
8 configuration. Similarly, transistors T3 and T4 are connected to each other in a
9 transmission gate configuration. The sources of transistors T1-T4 are connected to
10 capacitor C_s of summing circuit **23**. The drains of transistors T1-T2 are connected to the
11 positive terminal of modulating voltage source V1. The drains of transistors T3-T4 are
12 connected to high impedance resistor **29**. Offset voltage source V2 couples modulating
13 voltage source V1 and high impedance resistor **29** to ground.

14
15 LNB control section **20** enters the transmitting mode when switch control
16 signal **31** is set to a logic low level. This turns the transmission gate formed by transistors
17 T1-T2 on and the transmission gate formed by transistors T3-T4 off. The modulating
18 signal from modulating voltage source V1 can then modulate the voltage to LNB amplifier
19 **25** through capacitor C_s, resistor R_s, and transistor Q_s.

20
21 LNB control section **20** enters the receiving mode when switch control signal
22 **31** is set to a logic high level. This turns the transmission gate formed by transistors T3-T4
23 on and the transmission gate formed by transistors T1-T2 off. Since the resistance of
24 resistor R_s is much smaller than the resistance of high impedance resistor **29** (i.e., R_s <<
25 R_H), the base of transistor Q_s is effectively coupled to the collector of transistor Q_s, causing
26 transistor Q_s to act as a diode. The impedance seen at the emitter of transistor Q_s is now
27 the impedance of diode-connected transistor Q_s in series with the impedance of filter **22**.
28 Since the impedance of diode-connected transistor Q_s is negligibly small, filter **22**, which

1 is formed by inductor L_p , resistor R_f and capacitor C_p dominates the impedance seen by
2 LNB amplifier 25.

3
4 As has been described, the present invention provides an improved LNB
5 control section within a set-top box.

6
7 While the invention has been particularly shown and described with reference
8 to a preferred embodiment, it will be understood by those skilled in the art that various
9 changes in form and detail may be made therein without departing from the spirit and scope
10 of the invention.